ACERIA TOSICHELLA KEIFER (ACARI: ERIOPHYIDAE) FROM WHEAT STREAK MOSAIC VIRUS-INFECTED WHEAT PLANTS IN ARGENTINA

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ABSTRACT - The wheat curl mite, *Aceria tosichella* Keifer (Acari: Eriophyidae), is reported for the first time in South America from Argentina. *Aceria tosichella* specimens were collected from Wheat Streak Mosaic Virus-infected wheat plants from Buenos Aires Province. The risk of dissemination of this eriophyid mite into unaffected neighboring countries of South America and need to adopt quarantine measures to avoid its dissemination are discussed.
Key words - Acari, Eriophyidae, wheat, *Triticum aestivum* L., corn, cereals, virus, quarantine measures, South America, Argentina.

INTRODUCTION

Aceria tosichella Keifer (Acari: Eriophyidae) was described from wheat (*Triticum sativa* Lam.) leaves from Zemun-Beograd, Yugoslavia, in 1969, and is commonly known as the wheat curl mite (WCM). For many years, *A. tosichella* was misidentified as *Aceria tulipae* (Keifer), a species described as a pest of tulip bulbs imported by the USA from Holland (Keifer, 1938). Besides tulip bulbs, it was also believed to infest onion, garlic and grasses. Shevtchenko *et al.* (1970) showed that the eriophyid species occurring in Liliaceae was different from the one from wheat and described *Aceria tritici* Shevtchenko as the wheat infesting species. However, before Shevtchenko's description, Keifer (1969) had already described *A. tosichella* to accommodate the wheat infesting species. Therefore, *A. tritici* became a junior synonym of *A. tosichella*. In spite of that, the name *A. tulipae* is still being used by some researchers for the eriophyid mite associated with wheat, especially in North America (Kozlowski, 2000). Elucidation of the host range of each species has recently led to the acceptance of *A. tosichella* for the species associated with grasses in North America and *A. tulipae* for the species associated with Liliaceae (Amrine and de Lillo, unpublished database).

Aceria tosichella has been reported in the main wheat production areas around the world: North America-Canada (Alberta, Ottawa e Ontario) (Harvey *et al.*, 1995; Seifers *et al.*, 1998); Mexico (Sánchez-Sánchez *et al.*, 2001) and the United States of America (Arkansas, California, Georgia, Idaho, Kansas, Michigan, Missouri, Montana, Nebraska, North Dakota, Ohio, South Dakota, Texas, Utah) (Keifer, 1954; Harvey *et al.*, 1995; Forster *et al.*, 2001; CABI, 2002); Europe - Armenia, Bulgaria, France, Germany, Hungary, Italy, Poland, Romania, Russia, Ukraine, United Kingdom and Yugoslavia (Shevtchenko *et al.*, 1970; Lapierre, 1980; Sukhareva, 1981, 1993; Oldfield and Proeseler, 1996; Credi *et al.*, 1997; Jezewska, 2000; Kozlowski, 2000; Golya *et al.*, 2002; CABI, 2002; Skoracka and Pacyna, 2005); Asia - China (Lin *et al.*, 1987 in Oldfield and Proeseler, 1996; Hong and Zhang, 1996), India (Oldfield, 1970) and Kazakhastan (Sukhareva, 1993); the Middle East - Jordan and Turkey (Oldfield., 1970); Africa - southern Africa (Meyer,1981); and Oceania - Australia and New Zealand (Oldfield, 1970; Baker *et al.*, 1996; Persley, 1998; FIP, 2003; Thomas *et al.*, 2004).

Aceria tosichella occurs mainly on wheat, but populations can also develop on sorghum (*Sorghum* sp.), barley (*Hordeum vulgare* L.), corn (*Zea mays* L.), oat (*Avena sativa* L.), rye (*Secale cereale* L.) and pearl millet (*Pennisetum glaucum* (L.) R. Br.) (Jeppson *et al.*, 1975). *Aceria tosichella* populations also infest a large number of grass species of minor economic importance and weeds (Amrine and de Lillo, unpublished database). Damages due to *A. tosichella* infestation include discoloration, curling or rolling of leaves, abnormal development of leaves and plant stunting. Stunting occurs because infested

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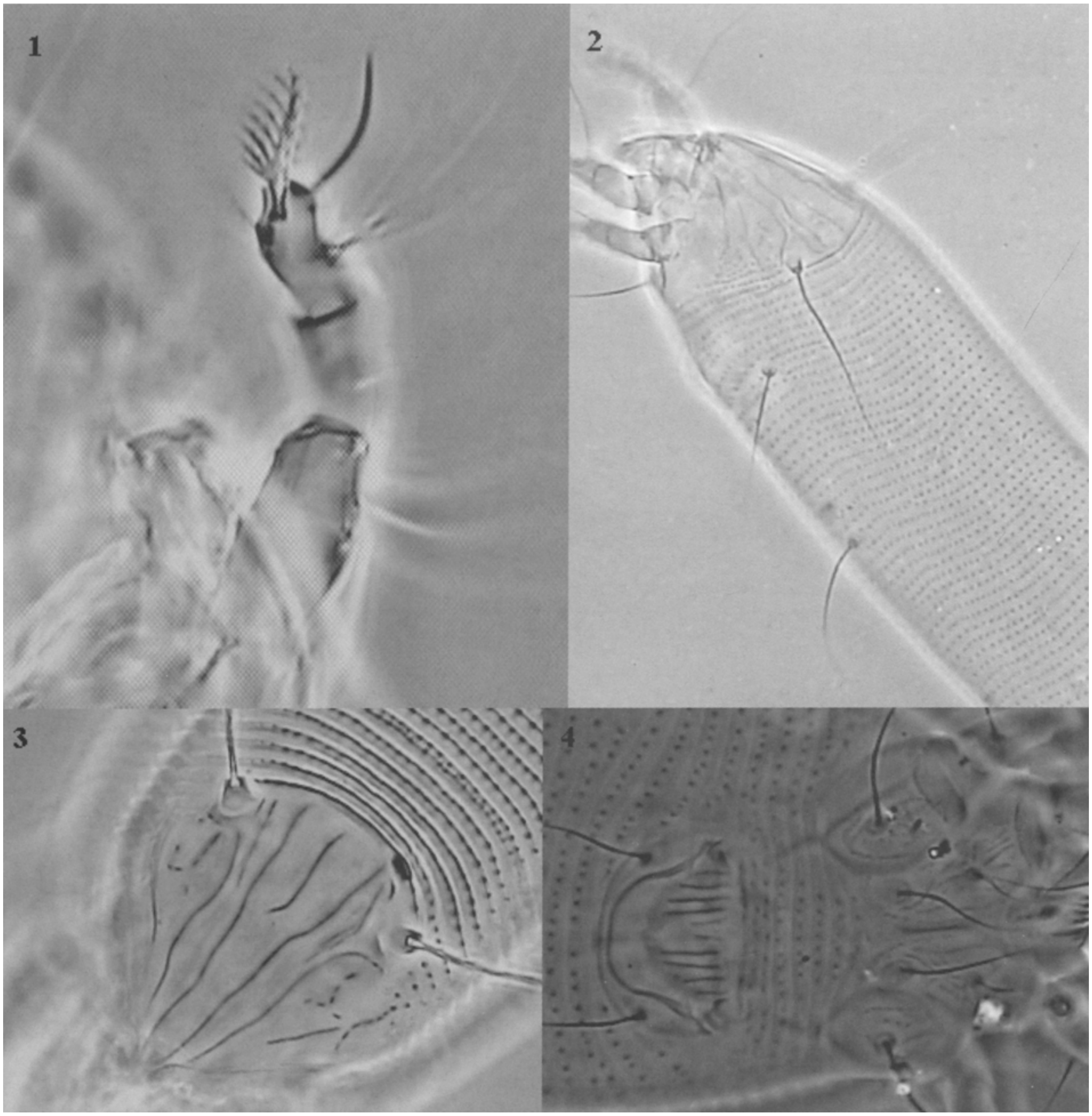

Figs. 1-4. *Aceria tosichella* Keifer from wheat in Argentina - 1. Eight-rayed empodium of leg I, 2. antero-lateral showing scapular seta (*sc*), 3. prodorsal shield, 4. coxigenital region.

leaves do not expand normally, remaining inside older leaves and the plant becomes arched (Jeppson *et al.*, 1975; CABI, 2002). Yield losses in wheat crops due to WCM high population infestations can reach 30% (Harvey *et al.,* 2002).

The main damage caused by *A. tosichella* is due to its ability to transmmit the Wheat Streak Mosaic Virus (WSMV) (Oldfield and Proeseler, 1996; Malik *et al.*, 2003ab). This virus is the etiological agent of one of the most important virus diseases in wheat crops causing major yield losses in North America and also occurs in Europe, the Middle East, Oceania and Asia (Oldfield and Proeseler, 1996; French and Stenger, 2003; Sánchez-Sánchez *et al.*, 2001). The WSMV transmission by *A. tosichella* has been confirmed by researchers in North America and Europe (Slykhuis, 1953; Oldfield, 1970). Wheat Streak Mosaic Virus is transmitted in a persistent circulative way (Slykhuis, 1955; del Rosario and Sill, 1965; Orlob, 1966; Oldfield and Proeseler, 1996). At present, *A. tosichella* is the only known vector of WSMV (Oldfield and Proeseler, 1996; Malik *et al.*, 2003).

Wheat Streak Mosaic Virus was reported for the first time in South America, in Argentina, in 2002, infecting wheat fields in Córdoba province, in the Central region of the country (Truol *et al.*, 2004). Later the presence of WSMV was also confirmed in Santa Fé, Santiago del Estero and Salta provinces. At that time there was no evidence of the presence of WCM, *A. tosichella*, in Argentina (Sagadín and Truol, 2005). The objective of the present work was to look for WCM on plants infected by WSMV in Argentina.

MATERIAL AND METHODS

In 2004, in the locality of Azul, Buenos Aires province, Argentina, samples of wheat cv. Baguette 10, with characteristic symptoms of WSMV were collected and processed for the WSMV diagnosis by indirect ELISA. Simultaneously, part of the sample was submitted for acarological inspection, using the washing method, to verify the presence of eriophyoid mites. This method consists in submerging plant tissue in detergent solution, shaking it to facilitate the detachment of superficial particles (including arthropods) and left to settle for 10 minutes. After that the solution was screened using 0.25, 20 and 270 mesh sieves, in ascending order. Smallest particles retained by the 270 mesh sieve were washed in 70% ethyl alcohol and examined under a stereomicroscope (40x). Eriophyoid mites detected were directly mounted in permanent microscopic preparations using modified Berlese medium (Amrine and Manson, 1996).

RESULTS AND DISCUSSION

Eriophyoid mites detected were identified as *A. tosichella*. Main characters used to identify *A. tosichella*, differentiating it from *A. tulipae*, were: 8-rayed empodium of leg I (Fig. 1) and 7 or 8-rayed empodium of leg II (7 in *A. tulipae*) and more developed microtubercles on the dorsal opisthosoma in *A. tosichella* Keifer (1969). Other characters observed in *A. tosichella* population from Argentina were: prodorsal shield acuminate anteriorly, with small lobe over base of gnathosoma (Fig. 3); scapular setae longer than prodorsal shield reaching 16th-20th dorsal annuli (counted from posterior margin of shield) (Fig. 2); prodorsal shield with longitudinal median line restricted to posterior half of shield; admedian lines complete; submedian lines sinuous, extending all over prodorsal shield and divergent in posterior region of shield; and marginal line not interrupted (Fig. 3). ELISA diagnosis of the WCM infested plants indicated the presence of WSMV. This is the first report of the presence of WCM, *A. tosichella* in Argentina and in South America.

Dissemination of WCM for short distances , as well as that of other eriophyoid mites, can happen naturally - by wind, pollinators, water (Lindquist *et al.*, 1996). Wind-borne movement of the WCM is of key importance in infestation and spread of WSMV. Thomas and Hein (2003) observed that the size of the source population is more important to the level of mite movement than the condition of the host plant. According to Gibson and Painter (1956) in CABI (2002) *A. tosichella* can also be disseminated by phoresy, especially with aphids. It is extremely important to adopt quarantine measures to avoid the fast dissemination of the WCM/WSMC complex and monitor the presence of this pest complex in wheat grown in adjacent areas not yet affected, including in neighboring South American countries.

No information exists regarding the way *A. tosichella* has been disseminated for long distances around the world and how it arrived in Argentina. Exchange and trade of wheat and other cereal and grass hosts of *A. tosichella* are done through shipment or distribution of seeds. Usually eriophyid mites are not able to disseminate with seeds but only through host plants propagation material or fruits. However there are cases of eriophyid mites that can be disseminated with seeds. *Trisetacus kirghsorum* Shevtchenko colonies develop inside *Juniperus* seed for two years, which corresponds with the duration of the ripening period of the seed (Oganezova and Pogosova, 1994). Other possibility is that *A. tosichella* has been disseminated through grasses in potted plants, considering that 127 grasses are its hosts (Amrine and de Lillo, unpublished database). It is necessary to investigate means of dissemination of *A. tosichella* for long distances to avoid its introduction into new areas.

It is possible that WCM has been present in Argentina for a long time causing minor damage and remaining undetected, and that WSMV had been recently introduced into Argentina through the seed trade. The known transmission rate of WSMV by seeds in maize is 0.03% and in wheat is 0.01 % (Truol, personal communication). These values are enough to justify the need for adopting quarantine procedures for seeds originating from countries where WSMV is present.

Aceria tosichella is also a vector of another etiological agent of disease of winter cereals: the High Plain Virus (HPV), that also infects barley, 'cheat' (*Bromus secalinus* L.), corn, oat and rye. The HPV was observed for the first time in the 1990s on the High Plains, in the western United States (Great Plains Pacific Northwest of US), in Texas, South Dakota, Nebraska, Idaho, Kansas and Colorado (Seifers *et al.*, 1997; 1998; Mahmood *et al.*, 1998; Skare *et al.*, 2002). Another virus is the Wheat Spot Mosaic in wheat in Canada and the United States, whose etiological agent is still unknown (Oldfield and Proeseler, 1996). At present these diseases have not yet been reported in Argentina or other South American countries. It is important to reinforce quarantine measures to avoid the introduction of these diseases on the continent considering its vector, *A. tosichella*, is already present in the risk area.

Malik *et al.* (2003a) reported the occurrence of six biotypes of *A. tosichella* found in Kansas, Nebraska, Montana, South Dakota, Texas (United States) and from Alberta (Canada). Different responses to resistant genes in different grass hosts were observed by Harvey *et al.*, (1995) and Malik *et al.* (2003a). Mite populations from different geographic origins vary in their ability to transmit HPV (Seifers *et al.*, 2002). It is necessary to conduct studies on the genetic variability and biotypes of *A. tosichella* populations present in Argentina and compare them with those from other geographic regions where studies have already been concluded. This information may be useful in developing quarantine measures and an integrated pest management program for wheat where the WCM/WSMV complex is present in South America.

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